

PAVEMENT MANAGEMENT WASHINGTON STYLE

**for
BEGINNERS**

**OR ANYONE WHO WANTS A
REFRESHER**

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The public expects and deserves streets and highways that are reasonably convenient, safe, and comfortable. They want goods and services made readily available at the lowest possible cost and industry wants to make those goods and services available in every location. Both consumers and suppliers must have reliable transportation to respond to these needs. They place their trust in the various local, State, and Federal agencies to maintain networks of streets and highways while wisely using the taxpayers money.

Government agencies are faced with the responsibility of balancing a budget, serving the public needs, and preserving the huge capital investment in roadways. Decisions need to be made as to what to do and when to do it. There are always more needs than there are available funds to accommodate those needs, and as new facilities are added in response to public demands, the burden of maintaining the facilities grows larger and more expensive.

In recent years it has become clear that the preservation and restoration of the deteriorating roadway networks is critical. Depending on the current general condition of the roadway surfaces, other aspects of roadway needs may be more easily seen by the public at large, but the preservation of existing facilities is crucial. To allow this huge investment of public funds to fail would betray the public trust.

The efficient management of a network of paved roadways has never been more important or difficult than it is now. The earliest way to manage pavements may have been to respond to failures when they occur and ignore the rest of the network. A much better way is to establish maintenance and resurfacing schedules based on the age of the segments of roadway in the network or their relative condition. Possibly the best procedure is a formal Pavement Management System (PMS). This is a relatively new approach to effectively and efficiently address the preservation needs of roadway networks. These formal systems all have a common goal, to do the best possible job of preserving the network with the available funds. In many cases the available funds are not enough. The PMS should be able not only to show that funds are inadequate, but also help determine what funding level is required to accomplish established goals. A PMS will also aid in administering the policies of the agency when difficult decisions are made. If fully adequate funds can not be obtained, it may be necessary to allow part of a network to fail while preserving the rest. Random failures throughout the full spectrum of functional classes and across all levels of usage may not be as favorable as allowing roadways of specific types to fail while efficiently preserving the more important routes.

Pavement engineers have always known that many factors are responsible for pavement deterioration and subsequent failure. Subgrade strengths, drainage, and construction materials and techniques all contribute to overall roadway strength and durability. The general environment and repeated heavy loads work against the roadway strength to cause damage, deterioration and eventual failure. As research is done and more knowledge is gained, better use of materials and better roadway designs should result in more predictable pavement behavior. However, pavement will always deteriorate over time.

A formal PMS should allow the pavement engineers to observe the systematic deterioration of the roadways. In order to observe the deterioration of a paved roadway, some measure of its condition must be defined and taken at regular intervals to observe change. It is very important to record successive measurements in a manner which allows direct comparison over time for specific segments of paved roadway.

Some compromise is required in a project level system since the pavement data collected is probably not detailed enough for full project development. The cost of in depth pavement investigation for the whole network would be excessive, and would make only a slight improvement in the process of project selection. As a result, more in depth investigation is required for each project once it is chosen for development into a programmed paving project. However, if the pavement quality or condition information gathered throughout the network is detailed enough to be meaningful at project level, summarization to the network level is generally easy. On the other hand, data collected strictly for network level purposes seldom includes enough detail to be very useful at project level.

Ride quality is a common measure of roadway condition. It is intended to assess the service and comfort of the traveling public. Panels of people are commonly used to assess the rideability of samples of roadway, and mechanical equipment is then used to measure the network of roadways to establish a ride value for all roadways. This ride quality value may be seen as a measure of service to the public. If ride quality gets very poor, damage to vehicles and cargo will result.

Another measure of roadway condition is accomplished by recording visible surface defects. The defects selected for observation and recording are generally indicative of defects which will eventually require rehabilitation. They usually include various forms of cracking, wear, and materials failures.

Formal pavement management, though not so named, in the Washington State Department of Transportation (WSDOT) began in the 1960's as a part of the Priority Programming process that was enacted into State law. In response to that law, WSDOT was required to prioritize proposed highway construction projects according to defined needs in a variety of specific categories. The focus was on *project* categories and priorities. Pavement preservation was one of those categories.

In response to the Priority Programming law, the WSDOT Materials Engineer was asked to devise a method to measure pavement needs and establish a means of prioritizing paving projects. He selected the ability to carry loads, structure, as the criteria, and developed a procedure to visually survey pavement condition. This procedure is still used today with only minor changes. The survey is accomplished by teams of technicians driving slowly along the roadway, observing, categorizing, and recording visible surface defects. Most of those defects directly or indirectly relate to loss of structural capacity. The predominant severity and estimated extent of each of several specific defect types are

recorded for a surveyed segment of roadway. The segments are of variable length (typically one mile), and the surveyors are instructed to make field breaks if the surface condition demonstrates a significant change.

When the pavement surveys were begun in the 1960's, the resulting survey data were stored in raw form electronically, compiled and reduced to numeric values. Specific values were assigned to each severity and extent of each type of observed defect. These values (deducts) were summed and subtracted from 100. This resulting value was modified by a ride quality index and the resulting number was called a Pavement Condition Rating (PCR).

A PCR value was established for every project segment on the network. These projects were then prioritized in order of most need (worst) first. This was, in essence, a reactive pavement management system since it reacted to the most recent pavement conditions in a systematic way. This is a giant step forward from a political or purely subjective approach to paving project selection, and it worked very well for over ten years. A dramatic improvement in pavement condition State wide during this time is testament to its effectiveness.

In the late 1970's, research was begun to investigate the possibility of creating a predictive PMS. It was apparent that such a system was feasible and the task of creating the Washington State Pavement Management System (WSPMS) was underway. Since WSDOT has historically focused on project development within a framework of network function planning, it was reasonable for Washington to develop a project oriented PMS. The decision to focus on project level considerations in the early development of the Washington State Pavement Management System has proven to be very adaptable to new developments. Since the system focuses on project oriented data collection and decision making, it can always be used to obtain summary information at the network level. The WSPMS is well adapted for network level tracking and projections while maintaining its project level orientation.

During development, some windfalls were present. First, a stable reference system (State Routes and Mile Posts) was already in place and being systematically maintained. Computerized data bases of construction history and roadway configurations were already in place. And, the pavement condition survey data had been collected, computerized, and stored (in its raw form) in accordance with the reference system from the beginning.

A great deal of effort was put into re-establishing numeric values to be assigned to the various types, severities, and extents of defects in the pavement surface. The goal was to define these new deduct values such that they would maintain a realistic relationship among the types and severities of defects; and also such that the deterioration of a segment of pavement over time could be quantified algebraically and graphically. The surveys included the predominant severity and total extent (in ranges) for each type of defect observed within each surveyed segment. A matrix of progressive deduct values was developed which represented relative severities among the various defects and extents.

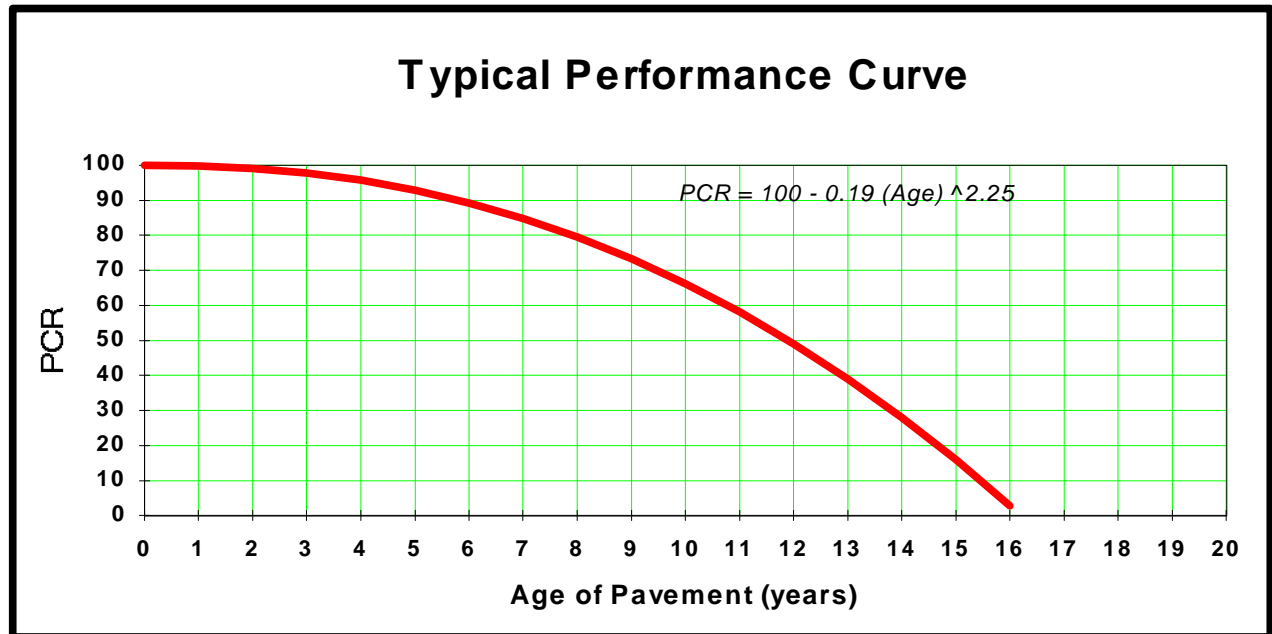
These deduct values were summed, subtracted from 100 and modified by a ride quality factor to obtain a value that represented the overall pavement condition for a specific segment of pavement. While a value of 100 indicated no defects, lower values represented deteriorating structure but were undefined. Negative values were appropriate.

WSDOT also measures ride quality, but it has played a very minor roll in the project selection and prioritization process. One reason for this is that WSDOT historically has seldom rehabilitated pavements strictly to improve ride. Also in many cases the most appropriate rehabilitation processes, notably chip seals and thin overlays, would achieve no appreciable improvement in ride quality. Probably the most important reason to use structure instead of ride quality is that ride degradation in flexible pavements only appears after the structure has suffered serious degradation. In general, by the time an aging flexible pavement demonstrates a reduction in ride quality, it has deteriorated well beyond the most economical time for preservation. Since over 85% of the pavement maintained by WSDOT is flexible, agency policies and procedures have concentrated on those types of pavements.

The notable exception is faulting Portland Cement Concrete Pavement (PCCP). Many faulted PCCP segments are structurally adequate, but the ride quality has degraded to the point of real need. Eventually the structure will fail, but in some areas the ride quality has already become intolerable. In Washington some rigid pavement rehabilitation must be accomplished due to ride quality degradation.

Recently WSDOT began a program of systematic and accurate measurement of ride quality and rut depths in order to include them in the WSPMS. Identification and measurement of rutting in flexible pavements and roughness on rigid pavements are needed to supplement the structure estimates in the WSPMS. In recent years both faulting of PCCP and rutting of flexible pavements have become more prevalent and it is imperative that the WSPMS systematically respond to the presence of those defects.

As a project level, structure based, predictive, Pavement Management System the WSPMS has proven itself. It has demonstrated very well that, if the accumulated damage done by both environment and loads are recorded throughout the life of the pavement, the deterioration may be shown algebraically and graphically. The resulting graph is called a performance curve. Successive years of condition yielded performance curves that could be used to show trends and predict condition into the future. This system, unique in the world, replaced the reactive processes for prioritizing paving projects in 1982.



While each section of paved roadway demonstrates its own rate of deterioration, the processes and effects of deterioration of a given pavement type are very similar. Of course, there are those unpredictable circumstances which may cause unexpected rates of deterioration and errors in data collection are always possible.

A performance curve which is unique to a specific segment of pavement can be created by pairing successive quantified condition values with the age of the segment of pavement in question. A curve can then be statistically fit to the group of points on the graph. This regression curve then describes the *historic* performance of the specified pavement segment.

To create and use performance curves for a network of pavement segments, those segments must be defined using a reliable and stable reference system. The data associated with any specific segment is then made available for use. In order to gain the benefits of performance curves in pavement management, it is essential to record the details of construction history and pavement conditions in accordance with the reference system. The historical data is of little benefit if successive years of collected information can not be directly compared.

WSDOT uses a Mile Post reference system for roadway data collection, system planning, programming, and locating various other highway related information. The maintenance of this, or any, reference system is no small task. While it is simple in concept, the details of maintenance and use can be quite complex, the benefits received from use of a stable reference system far exceed the difficulties associated with its use and maintenance.

For pavement management purposes, the best results will be obtained if each segment is relatively homogeneous. That is having the same pavement section characteristics and the same exposure to environment and traffic. Two basic types of segment are used by pavement managers; static and dynamic.

The static segment is the easiest to manage since its end points remain fixed and field data can be directly related to the segment. There is, however, the possibility that the segment may not perform similarly throughout its length and that rehabilitation may take place over part of its length. If this occurs, then the segment is no longer homogeneous and re-definition of the segment into two or more segments may be required. Careful initial definition of segments may avoid, or at least minimize, future re-definitions.

The WSPMS uses dynamic segmentation of the roadway network which is generally more difficult to manage, but is required by circumstance. The construction done in the past generally controls the segmentation, and since no policy within the WSDOT requires that rehabilitation work must use historic end points, new rehabilitation projects usually define new segments. The construction history and planned future work are kept in two separate computer data bases. The WSPMS accesses these data bases and is recreated from scratch using the data found in those data bases. Since termini of paving projects, both historic and future, are not aligned to static locations, then a dynamic approach is more reasonable. Using this approach, the computerized PMS can determine the end points of the homogeneous segments based on previous construction limits, jurisdictional boundaries, functional classification, pavement performance, and other criteria. As new or changed termini or boundaries are defined, new pavement segments are defined. In WSDOT these homogeneous segments are called Analysis Units. One of the principal drawbacks to dynamic segmentation is that segment lengths may often be very short and not directly usable as future projects or survey break points. Field pavement condition data is collected and related directly to the reference system with field termini established at regular intervals. Special break points are added at documented proposed project end points and by observed differences in overall condition in the field.

Individual bridges are also defined as Analysis Units in order to maintain the homogeneity of adjacent pavement segments. Since Analysis Units are frequently very short, the historic condition data may not have been collected specifically for each segment. In alternate years a short segment may have been included in the field survey with segments behind or ahead. As a result, pavement condition data may yield erratic performance curves for some individual Analysis Units. However, the data and curves associated with most Analysis Units are very reliable.

Since the Analysis Units are defined as homogeneous segments, they can be grouped and summarized to obtain typical performance characteristics. Grouping by pavement type, functional class, District, and other criteria allows the development of a set of Standard Performance Curves. This set of standard curves is essential for developing predictive models.

Once the data is collected and analyzed, a performance curve for each Analysis Unit is created. Those curves which are statistically acceptable and have demonstrated a significant trend are used to create the standard curves, the remainder are ignored in the standard curve development process. The individual curves from which the averages are developed demonstrate a wide range of life expectancies and each is equally valid. Many attempts have been made to group these curves to obtain tighter correlation, but the ranges are always large. If grouping definitions are very stringent, too few samples will be selected to yield statistically significant models. These standard curves are used directly when no data is yet available for a new pavement and for helping to predict rates of deterioration when trending has not developed in curves with limited performance data.

Since the Standard Performance Curves represent grouped averages, and they are adjusted for current trends annually, their probability for accuracy at network level is very high. Long range network projections are likely to be quite valid providing no significant changes in related paving policies or procedures occur.

Analysis Unit curves and the generalized curves developed from them are useful, and necessary, for network level decision making and performance reporting, but project specific curves are required for analyzing proposed projects. Since the process of programming and developing rehabilitation projects may require several years, one of the primary goals for the WSPMS is to predict the timing for future rehabilitation projects. It is also used to suggest the termini of future projects when a proposed project has not been defined.

To predict future rehabilitation needs and timing for paving projects requires the use of predictive performance curves. Once a performance curve has been developed for each Analysis Unit, the preferred time for rehabilitation of each can then be predicted. By combining adjacent segments, when necessary and feasible, the termini of future, previously undefined, paving projects may be suggested. If a planned project exists, its termini are used. PMS projects are defined for the whole highway network, with no gaps or overlaps, using either planned termini or computer suggested termini. The condition data is then summarized using the PMS project termini and is used to create a performance curve specifically for each proposed project.

When combining segments of pavement into one proposed project several operational policies must be defined. A minimum desirable length is usually established to avoid defining projects which would not reasonably be constructed. This is bound to conflict with special performance problems. If a short segment is performing poorly and it is combined with others, the apparent performance of the whole project is effected. Since WSDOT generally does a verification inspection of project sites prior to including them in the next program, these anomalies can be easily dealt with. The alternative is to allow many short projects. Other fixed project break points, such as change in functional class or District, may fall very close to a defined project limit. This may also cause an unreasonably short project to be created by the PMS. Careful establishment of proposed

project termini will avoid most of these difficulties, but there will always be need for good judgment when using computer generated information.

A performance curve for each specific segment of pavement (Analysis Unit or Project) is developed using the following procedures:

If there is no pavement condition rating for the segment, then the appropriate standard performance curve is used.

If there is only one pavement condition rating for the segment, then the appropriate standard performance curve is used as a template to continue the curve beyond that single point.

If there are two or more pavement condition ratings for the segment, then a regression analysis is done and a regression curve is defined. Then a second curve (Type 3) is developed using the appropriate standard performance curve as a template to continue the curve beyond the most recent point along with the previous condition data. If the regression curve agrees favorably with the Type 3 curve, then the regression is kept, otherwise the Type 3 curve is kept.

Using the performance curve, several predictions can be made. It can be determined *what condition* the pavement will be in at some future time, or *when* the pavement will reach a specific condition. These predictions represent *probable* conditions into the future. The reliability of each prediction is dependent on the amount (number of points) of the specific data available, the trends demonstrated (if any), and the extension into the future along the curve that is used. If the performance curve demonstrates significant trending then the accuracy of projection into the near future is reasonably reliable.

If the pavement manager is only interested in ranking the conditions of pavements at some future time, then he or she would use the performance curves to predict the conditions of each project at that time. The projects could then be ranked according to the predicted pavement condition. This is an easy and direct way of determining the needs at some future point in time, usually one or two years into the future. WSDOT used this procedure for a few years immediately following the development of the WSPMS. There are some drawbacks to this procedure however. Due to the greatly different rates of deterioration, projects will change sequence when ranked in different years. So a new ranked list in the next cycle will reshuffle the list significantly. Most agencies need to plan for more than one year in advance, so the preservation rehabilitation needs of several future years are required at the same time. While some shifting of position is to be expected, it is preferable to minimize those occurrences as much as possible. Few, if any, agencies can fund programs which address all of the needs as they come due, particularly when further complicated by the unavoidable peaks and valleys of the approaching needs.

A better procedure is to predict *when* each project will reach a condition that warrants rehabilitation. The whole network of projects can then be seen as a register of needed preservation work. Some early preliminary preparation tasks can be accomplished on a variety of related projects well in advance of the actual rehabilitation. While this procedure has tremendous advantages, caution is advised when viewing more distant future portions of the list of needs. Individual project performance projections will be adjusted as each successive collection of condition data is added, and more distant projections are likely to change. Fixing the rehabilitation schedule for a specific project too far in advance will adversely effect the timely and adequate rehabilitation of those which may come due sooner than initially expected. While all projects will be required eventually, rehabilitation work might also be begun on some projects sooner than would be otherwise desired.

In a dynamically defined network, it is useful to define project termini two or more cycles in advance of commitment. This allows for specific tracking and projection of the defined project. Termini adjustment to optimize the program sequencing strategies in consecutive years can be done prior to final commitment of resources.

Since its initial development, the WSPMS itself has been very dynamic. As new ideas arise, or new knowledge of pavements becomes available, the WSPMS is modified to take advantage of the latest concepts. As part of a current pavement management research project, a fresh look at definition of pavement condition has taken place. Using the experience of several years of successful pavement management coupled with in depth pavement research, it became apparent that a new, more useful value could be assigned to pavement condition. This process was implemented in 1991 by WSDOT. The old Pavement Condition Rating (PCR) has been replaced by a Pavement Structural Condition (PSC). The PSC is also be a scale of zero to 100, but unlike PCR, there are no negative numbers. The old PCR could develop negative values below -20, but they were essentially meaningless. In general terms, for flexible pavements, a PCR of -20 is equivalent to new a PSC of zero.

It is generally accepted that a homogeneous segment of flexible pavement (ACP and BST) has lost about half of its strength when it displays ten percent serious fatigue cracking. This level of fatigue is now defined as an PSC of 50. While some strength exists at much higher levels of fatigue cracking, the continued exposure to the effects of environment and traffic may totally destroy portions of the roadway before fatigue is evident in other areas. The increasing risk of complete failure and the subsequent reconstruction requirement at higher levels of fatigue has led the WSPMS to define total loss of strength at 40 percent or more serious fatigue cracking. Relationships to serious fatigue cracking have been established for each of the other surveyed surface defects. These newly developed relationships will allow for direct connection of observed condition to probable strength. Since these relationships are very general, and the true strength of the pavement is dependent on many variables, the PSC value is only an estimate. As more research is

done, minor adjustments may be required in the future. A similar, though more complex, research into PCCP definitions is planned for the near future.

WSDOT defined "EqC" as the base for equating all forms of cracking. Then relationships for each type and severity of cracking to "EqC" were developed. While all cracking is not fatigue related, some loss of strength may be shown for all cracks. More importantly, these values will also permit observation of the systematic deterioration of the pavement.

<u>Assume:</u>	deduct=0	deduct=50	deduct=100
EqC = Severe Alligator	0%	10%	40%
Medium Severity Alligator	0%	15%	50%
Low Severity Alligator	0%	25%	70%

by regression (deduct vs. percent EqC) and rounding:

$$\text{Deduct} = 15.8 * \text{EqC} ^ 0.5$$

by regression (percent severe vs. percent moderate) and rounding:

$$\text{EqC} = 0.445 * \text{Moderate} ^ 1.15$$

by regression (percent severe vs. percent low) and rounding:

$$\text{EqC} = 0.13 * \text{Low} ^ 1.35$$

Assume:

High Severity Patches (dig-outs) are equivalent to High Severity Alligator Cracking, 75% of Medium Severity Patches (blade laid) are equivalent to Medium Severity Alligator Cracking, and 75% of Low Severity Patches (chip seal) are equivalent to Low Severity Alligator Cracking.

Assume:

Four full length Longitudinal Cracks (400%) plus 100 Transverse Cracks per 100 feet are equivalent to six full length Longitudinal Cracks (600%) plus 66 Transverse Cracks per 100 feet. Also each combination is equivalent to 100% Alligator Cracking (12 inch by 18 inch blocks in the wheel paths).

by simultaneous solution:

$$400L + 100T = 600L + 66T = 100 \text{ EqC}$$

$$33T = 200L$$

$$T = 6L \text{ (approx.)}$$

by substitution:

$$400L + 600L = 100 \text{ EqC}$$

$$1000L = 100 \text{ EqC}$$

$$L = 0.1 \text{ EqC}$$

$$100T + 66T = 100 \text{ EqC}$$

$$166T = 100 \text{ EqC}$$

$$T = 0.6 \text{ EqC (approx.)}$$

THUS:

Alligator Cracking (% of length of Wheel Tracks)

EqC = High Severity

EqC = $0.445 * (\text{Moderate Severity}) ^ {1.15}$

EqC = $0.13 * (\text{Low Severity}) ^ {1.35}$

Patching (% of length of Wheel Tracks)

EqC = High Severity

EqC = $0.445 * (0.75 * (\text{Moderate Severity})) ^ {1.15}$

EqC = $0.13 * (0.75 * (\text{Low Severity})) ^ {1.35}$

Longitudinal Cracking (% of length of Segment)

EqC = $0.1 * (\text{High Severity})$

EqC = $0.445 * (0.1 * (\text{Moderate Severity})) ^ {1.15}$

EqC = $0.13 * (0.1 * (\text{Low Severity})) ^ {1.35}$

Transverse Cracking (Count per 100 feet along length of Segment)

EqC = $0.6 * (\text{High Severity})$

EqC = $0.445 * (0.6 * (\text{Moderate Severity})) ^ {1.15}$

EqC = $0.13 * (0.6 * (\text{Low Severity})) ^ {1.35}$

All EqC values are summed and the deduct is computed as:

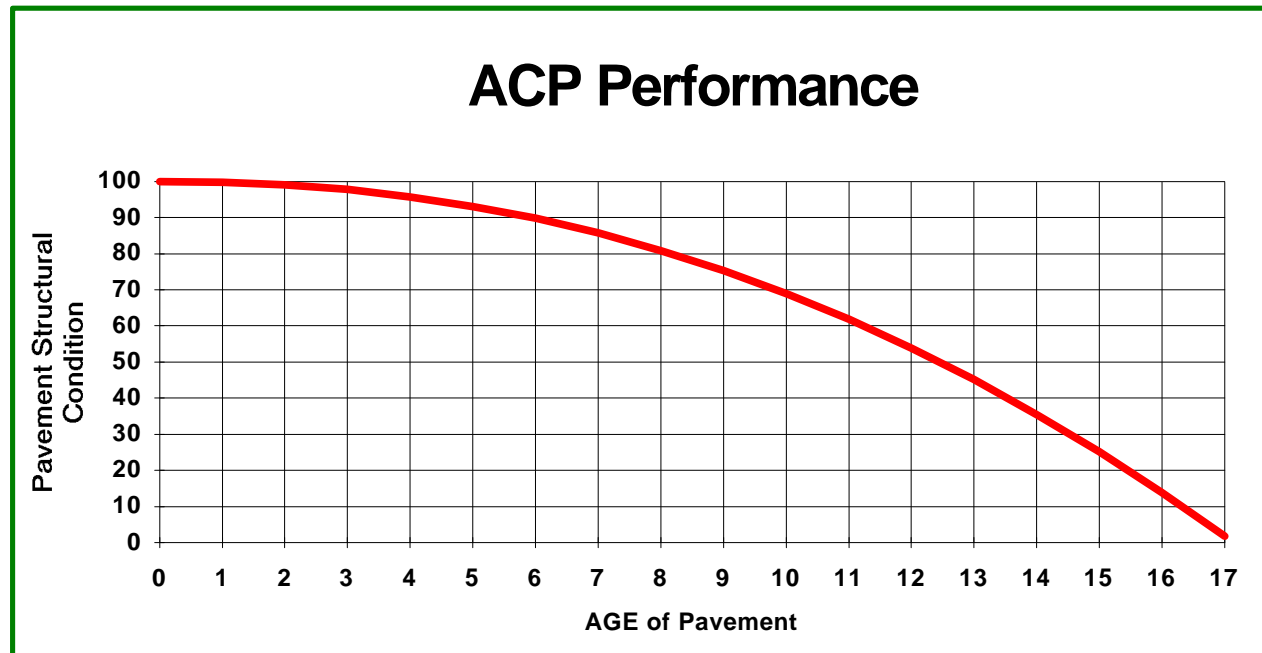
Deduct = $15.8 * \text{EqC} ^ {0.5}$

If the Deduct is greater than 100, then Deduct = 100.

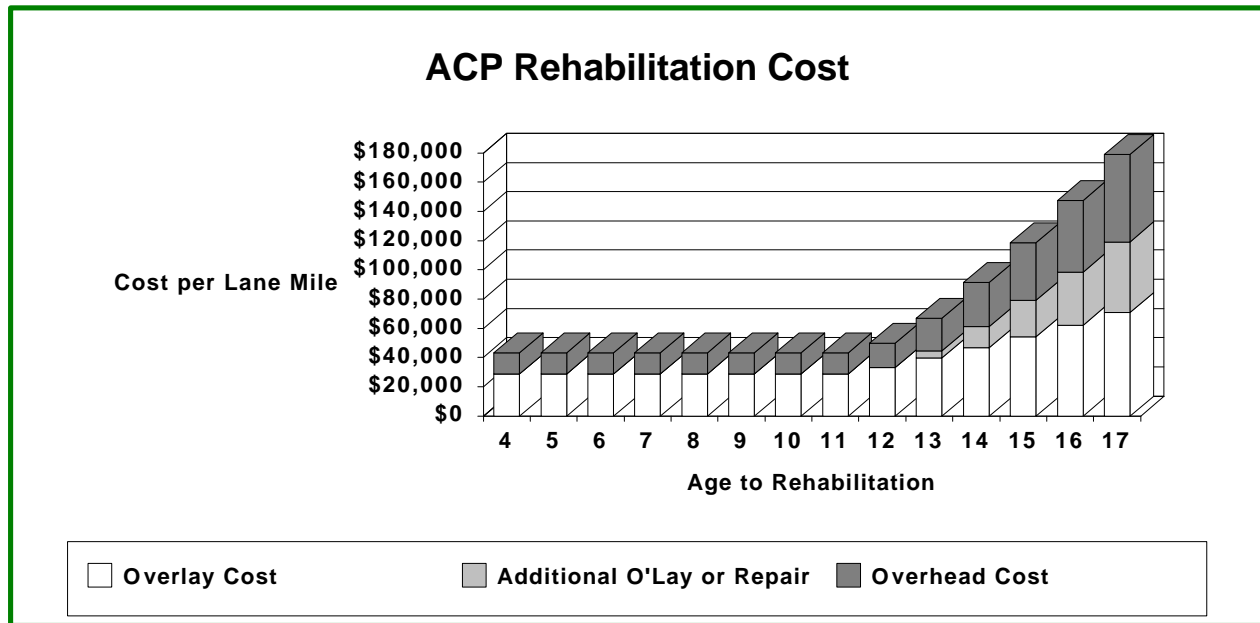
PSC = $100 - \text{Deduct}$

Adequate rehabilitation of a pavement requires that enough additional strength be added to the segment of pavement to withstand the repeated loading throughout the design life of the rehabilitation project. This strength is usually added in the form of an overlay. The thickness of the overlay required is the subject of much research into pavement design technology. Simply stated, the overlay strength requirement is the difference between the required new design strength for the roadway and the strength of the existing roadway section. New design requirements are determined by traffic loading and subgrade strength. It is the percent of existing strength of the roadway section that is estimated by the WSPMS for developing performance curves. The condition survey and subsequent computation of numeric condition values are very valuable tools for estimating the strength of the existing pavement section, but a much more rigorous estimate is required for designing an adequate overlay. It is completely impractical to do rigorous field testing and design computation for the entire network of pavement on a regular basis. For this reason, the WSPMS performance curves are created using observed pavement defects to estimate and relate loss of strength to the age of the pavement.

Establishing a condition at which rehabilitation is recommended is an important requirement of predicting *when* projects ought to be rehabilitated. Definition of this condition varies from agency to agency and selected measure(ride, structure, etc.). The WSPMS bases its definition on structural ability of a pavement to carry loads. The quantification of the pavement condition is an estimate of that ability.

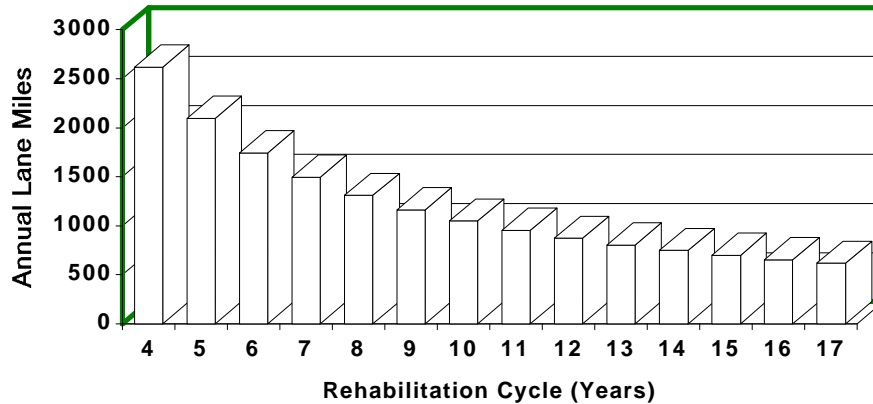


The overlay thickness of a specific segment of pavement is inversely proportional to the remaining strength of the existing pavement. That is, if the existing strength declines by ten percent, the required overlay thickness will increase by about ten percent. Of course, the actual overlay thickness depends on traffic and subgrade modulus. As the condition is allowed to deteriorate into the lower ranges, significant repair work will be required in addition to an overlay. This additional work, of course, adds to the cost of rehabilitation. At the extreme low end of the performance curve, total reconstruction may be the only way to restore the integrity of the roadway pavement.



The cost of rehabilitation in the upper and middle ranges of condition is proportional to the overlay thickness plus, of course, the contingent costs of undertaking the paving work. There are very significant life cycle cost benefits achieved by accomplishing rehabilitation in the upper and middle ranges of the performance curve. Rehabilitation in the upper range may reduce the cost, but it is unnecessarily disruptive and increases the number of projects required each year. Rehabilitation in the lower range not only increases the initial cost proportionally, but greatly increases the risk of high cost additional work to restore the pavement to service. Cost of rehabilitation at the lower end of the curve can often be three or four times the cost of preservation done in the middle range.

ACP Network

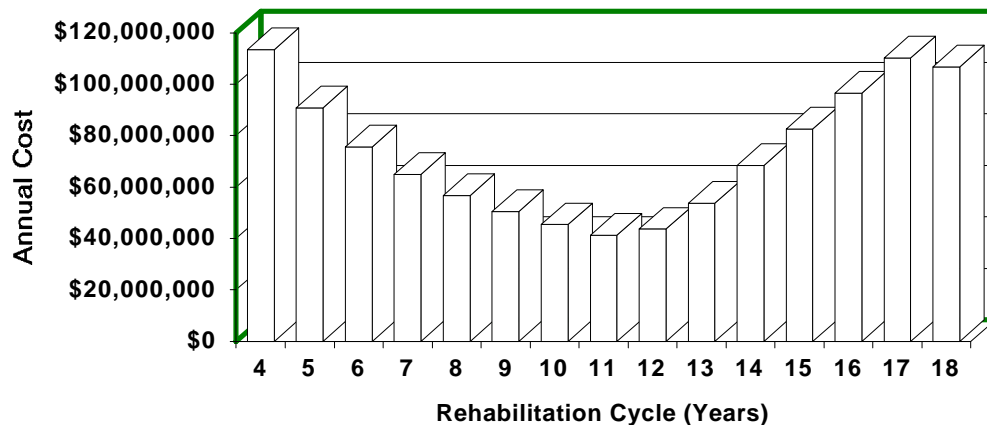


The ACP Network graphic shows the relationship of the rehabilitation cycle to the number of lane miles required annually. The more frequently that each mile is revisited, the more miles must be done each year. Conversely, fewer miles done each year requires longer periods of time between treatments. One might assume that fewer miles per year would reduce the annual cost to preserve the network. However, as each mile is allowed to deteriorate with time, the cost to restore that mile increases.

We can use the average performance curve to model annual cycles. When the number of miles rehabilitated each year at a given frequency or pavement age is multiplied by the cost to accomplish the work in the condition expected at that age, the result is the annual network rehabilitation cost for that frequency. Using several different frequencies we can analyze the effect of different age, condition, and cost combinations.

When an analysis of annual network preservation costs is made considering typical cost per lane mile at various pavement conditions in conjunction with the percentage of a network that must be rehabilitated annually at that condition, it becomes clear that the lowest annual preservation cost will be found at mid-range of the performance curve. An alternative low annual cost would be found much further out in time, but the public would be using a facility which has been in very poor condition for a number of years before rehabilitation took place.

Network ACP Rehabilitation Cost



The preceding graphics represent a typical network of pavements all of which behave in an average way. You will note that the lowest annual cost correlates with a PSC of approximately 50.

Throughout this discussion it is assumed that adequate overlay thickness was used for the rehabilitation paving project. If inadequate thickness is used, the pavement will not demonstrate the expected performance. It will deteriorate more rapidly, creating a shorter performance curve, and require rehabilitation sooner. The same phenomenon occurs when poor construction practices or materials are employed during the paving operation. Many factors are involved in proper pavement design and construction, and each contributes to good or poor performance. The effects of these variables cause a great divergence of performance experience from what appear to be similar pavements. The average performance curves used for modeling must be driven by real pavement performance in the field. As the typical performance in the field changes, the models must change to reflect the real experience.